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Department of Energy
Richland Operations Office
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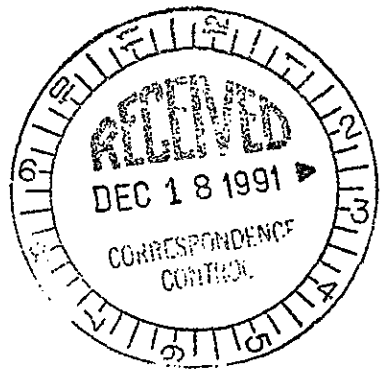
DEC 13 1991

91-WOB-452



Mr. Timothy L. Nord
Hanford Project Manager
State of Washington
Department of Ecology
Mail Stop PV-11
Olympia, Washington 98504

Dear Mr. Nord:

SOIL/BENTONITE REMEDIATION AND FREEZE MINIMIZATION PLANS

References: (1) Letter, Timothy L. Nord, Ecology, to Steven H. Wisness, RL, "Intent to Deny Interim Status for the Liquid Effluent Retention Facility," dated November 18, 1991 17539

(2) Letter, Moses Jaraysi, WDOE, to Cliff Clark, RL, "LERF: Freeze/Thaw Effect on Soil/Bentonite," dated November 5, 1991 ✓

The enclosed "Inspection and Construction Action Plan for Remediation of the Soil/Bentonite" when combined with the enclosed "Soil/Bentonite Freeze Minimization Plan" provides the information requested by the referenced letters.

The Inspection and Construction Action Plan for Remediation of the Soil/Bentonite has been discussed and approved with the Ecology Staff on Lacey, WA on November 21, 1991.

The Soil/Bentonite Freeze Minimization Plan was discussed with Mr. Moses Jaraysi of your staff on December 2, 1991 and December 3, 1991 by Mr. S. L. Petersen of Kaiser Engineers Hanford. Mr. Jaraysi's comments have been incorporated into the document.

Remediation of the soil/bentonite began on November 22, 1991; however, excessive rain prevented progress until December 2, 1991. Installation of the high density polyethylene liner on the slopes of Basins 43 began on December 3, 1991 consistent with the enclosed plans and the project specifications.

Questions on this should be directed to Mr. L. S. Mamiya on (509) 376-1471.

Sincerely,

Steven H. Wisness
Hanford Project Manager

WMD:LSM

Enclosures 2

cc w/enc.
P. Stasch, Ecology
G. Anderson, Ecology
M. Jaraysi, Ecology
T. Michelena, Ecology
W. H. Hamilton Jr., WHC
D. E. Kelley, WHC
R. J. Julian, WHC
L. R. Tollbom, WHC
T. B. Veneziano, WHC

December 2, 1991

SOIL/BENTONITE FREEZE MINIMIZATION PLAN

This document completes a commitment established between Ecology, the Department of Energy, Kaiser Engineers Hanford Company and Westinghouse Hanford Company on November 21, 1991 to provide the subject plan by December 6, 1991. A draft copy of this plan was sent by FAX to Moses Jaraysi and Paul Stasch of Ecology on November 25, 1991. As a result of the December 2, 1991 meeting between Steve Petersen (KEH), Dave McShane (KEH), Roy Tollbom (WHC) and Moses Jaraysi (WDOE), WDOE's comments have been resolved and incorporated into this document.

1. PLAN

   A. Remediate S/B per specification and plan approved on November 21, 1991.

   B. Cover or blanket surfaces as soon as remediated to minimize the effect of freezing on the soil/bentonite. (Do not leave uncovered during freezing weather.) The objective is to install liner system materials over the soil/bentonite (S/B) as soon as possible.

2. FROST HISTORY AT HANFORD

   A. 0.5 to 2-inches of frost depth is anticipated during December.

   *B. A 6" to 15" frost depth range is anticipated during January.

3. DESIGN FEATURES THAT MINIMIZE THE RESULT OF FREEZING

   A. The probability of freezing soil/bentonite decreases as the following installations occur:

      1. Bottom HDPE liner

      2. Gravel (12-inches, air in layer adds insulation)

      3. Two layers of geotextile

      4. Claymax carpet liner

      5. Top HDPE liner

      6. VLDPE cover

* The 6" - 15" frost depth range is an interpolation of attached table 9 "Subsoil Temperature Data". This information was extracted from the "Climatological Summary for Hanford Area" prepared by Battelle for the U. S. Department of Energy, June 1983. A copy of this report will be supplied to Moses Jaraysi of WDOE.

B. If the soil/bentonite on the sides experienced freezing to a depth of 15-inches, and credit is not taken for the various liner elements above the S/B, 27-inches of S/B on the sides would remain with a permeability of approximately 2.4 X 10^{-8} cm/sec. The 27-inches of soil/bentonite will allow operation of the facility for 90 years which is three times the design life.

C. If a large leak occurs, the basin will be pumped down.

CHEN-NORTHERN REPORT

1. Clay liners are known to decrease in permeability 1 to 3 orders of magnitude due to freezing. No research has been published concerning the effect of freezing to soil/bentonite.

2. One report is available from Sweden that found that a S/B composite exhibited minimal adverse effects to permeability upon freeze-thaw cycling. The type of composite, test methods, and application to the LERF configuration is not known at this time. As of October 15, 1991, the Swedish report was being translated for transmittal to the U. S. Army Corp of Engineers. Currently, additional steps are being taken to obtain the translated version of this report which will be provided to WDOE as soon as it becomes available.

The above information is a summary from a thorough and detailed report regarding the freeze issue. A signed copy of the above report is available and will be provided to Moses Jaraysi.

S. L. Petersen, Project Manager — 12/3/91
Kaiser Engineers Hanford Company — Date

L. R. Tollbom, Project Engineer — 12/3/91
Westinghouse Hanford Company — Date

TABLE 9. Subsoil Temperature Data (High and Low Extremes of Average Monthly Subsoil*)

	AVERAGE MONTHLY SUBSOIL TEMPERATURES*			-0.5 INCH				-15 INCHES				-36 INCHES			
	-0.5"	-15"	-36"	HIGHEST MONTHLY AVG	YEAR	LOWEST MONTHLY AVG	YEAR	HIGHEST MONTHLY AVG	YEAR	LOWEST MONTHLY AVG	YEAR	HIGHEST MONTHLY AVG	YEAR	LOWEST MONTHLY AVG	YEAR
JAN	31.1	36.0	42.4	39.4	1967	16.3	1949	41.3	1967	25.5	1979	48.7	1975	36.3	1979
FEB	38.5	39.0	42.1	44.7	1967	30.6	1950	44.9	1967	29.6	1957	45.9	1967	33.5	1957
MAR	48.0	46.4	45.1	54.0	1968	42.4	1955	52.6	1968	40.3	1955	51.7	1968	41.8	1955
APR	60.1	55.2	52.9	69.4	1977	53.2	1970+	62.1	1977	48.7	1955	57.4	1966	47.3	1955
MAY	72.8	65.4	60.7	83.6	1947	65.2	1959	70.4	1966	58.5	1955	64.3	1968	54.8	1955
JUNE	82.0	74.9	68.8	88.1	1974	74.2	1953	84.5	1966	67.2	1953	73.4	1969	64.0	1953
JULY	91.2	81.7	75.5	96.2	1968	84.0	1955	88.1	1967	75.4	1955	81.2	1967	70.9	1955
AUG	87.5	82.3	78.7	94.8	1971	81.6	1960	89.2	1967	77.3	1954	83.9	1967	74.6	1954
SEPT	74.3	74.5	74.8	81.0	1957	67.0	1959	82.2	1957	68.8	1955	81.4	1967	70.1	1978
OCT	56.7	62.6	67.1	62.3	1965	51.7	1946	66.6	1967	57.9	1957	72.3	1967	62.9	1959
NOV	41.4	49.0	56.7	46.2	1949	34.5	1952	54.0	1974	44.6	1978	62.7	1974	52.6	1959+
DEC	33.8	39.7	47.7	39.4	1969	27.1	1978	45.0	1974	34.4	1978	54.6	1974	44.9	1978+
ANNUAL	59.8	55.9	59.5	62.8	1967	57.3	1959	63.0	1967	56.1	1957	63.2	1967	57.6	1957
				ABSOLUTE HIGH AND LOW SUBSOIL TEMPERATURES											
				150.0	1971	-3.0	1949	93.0	1967	16.1	1979	85.3	1967	32.0	1957

* -0.5 INCH PERIOD OF RECORD 1945-1980
-15 INCH AND -36 INCH PERIOD OF RECORD 1952-1980
+ DENOTES ALSO IN EARLIER YEARS

Chen Northern, Inc.

[illegible]

[illegible]
P.O. Box 2608
[illegible]

[illegible]
[illegible]

October 15, 1991

Kaiser Engineers Hanford Company
P.O. Box 888
Richland, Washington 99352

ATTENTION: Mr. Stephen Petersen

SUBJECT: Research of Freeze-Thaw Issue;
W-105 Soil-Bentonite Liners

Mr. Petersen:

In response to your request of September 3, 1991, we have researched several aspects of freeze-thaw effects on the soil-bentonite used at the W-105 project. Between September 3, 1991, and October 15, 1991, we contacted (by phone) apparently all of the recognized authorities on the subject from both industry and government. The list of personnel presented in the Appendix reflect those persons who contributed substantive information. The issues addressed in all conversations included technical background and the state of freeze-thaw research (pertaining to soil liners), existing permitted RCRA sites and the issue of freeze-thaw, and the present involvement of the U.S. Environmental Protection Agency regarding freeze-thaw of soil liners. Additional research of the available literature was also used in development of this letter.

BACKGROUND

At issue is the impact of freezing and thawing conditions on permeability of soil liners used in liquid and solid waste impoundments. As was originally mandated in the 1987 EPA guidance document concerning permitting of RCRA landfill sites, one component of the liner system is to consist of the soil (clay or composite) liner system of some minimum thickness (usually 30 inches), with a maximum in-place hydraulic conductivity ("permeability") of 1x10 -7 centimeters per second. Limited research has indicated that freeze-thaw cycling of compacted clay liners may contribute to increases of permeability from one to three orders of magnitude. At the present, no research has been published (in the U.S.) which studied the effect of freeze-thaw on a soil-bentonite liner materials.

STATE OF FREEZE-THAW RESEARCH

Research involving the freeze-thaw effects on soil liners is presently relatively limited, both in the scope (regarding material types) and in the actual amount of research that has been performed

with published results. Our research of available literature and conversations, including existing published draft data, and personal conversations with sources in both government and industry (personal contact references 1 - 6) indicates that primarily three parties (and their associates) are engaged in such research. These researchers include Mr. Edwin Chamberlain, P.E. of the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), Dr. Thomas F. Zimmie, PhD, P.E. of Renssalaer Polytechnic Institute, and Dr. David Daniel. PhD of the University of Texas, Austin. These parties have published several papers on the subject of freeze-thaw effects on compacted clay liner materials (see list of reference documents in the Appendix). Their research indicates that (in general) permeability of compacted clay liners is (adversely) effected by freeze-thaw cycling, wherein the permeability of the frozen and thawed liner clay may increase one to three orders of magnitude. Dr. Zimmie's research also indicates that the adverse effects of freeze-thaw cycling may be somewhat mitigated upon increasing confining pressure, such as when waste is placed over the liner.

Our geotechnical engineer asked all of the contacted parties (personal contact references 1 - 6) about research regarding soil-bentonite composite liners. All of the parties indicated that no research has yet been published in the U.S. regarding freeze-thaw effects on a soil-bentonite composite. Mr. Chamberlain of CRREL indicated however, that a report recently published in Sweden found that a soil-bentonite composite exhibited minimal adverse effects to permeability upon freeze-thaw cycling. The type of composite, test methods, and product application are presently unknown. Mr. Chamberlain indicated that he would forward a copy of the report upon receipt and translation.

EXISTING PERMITTED RCRA LANDFILL/IMPOUNDMENT SITES

We performed limited research into permitted RCRA landfill or impoundment sites with climatic conditions similar to those conditions encountered at the Hanford Site. The results of our research indicate that at least two such permitted RCRA sites are found in the western U.S. These sites include the U. S. Pollution Control Inc. (USPCI) Grassy Mountain Site near Knolls, Utah (west of Salt Lake City) and the Chemical Waste Management site near Arlington, Oregon. Based on our conversations with state regulatory and design personnel associated with the sites (personal contact references 7 and 9), freezing of the liners was not an issue in obtaining permits at these sites.

U.S. EPA RESEARCH/REGULATION

During our conversations with Mr. Robert Landreth, Program Manager of U.S. EPA Research in Cincinnati, Ohio, (personal contact

reference 8), Mr. Landreth indicated that EPA was aware of and is in the process of researching the freeze-thaw issue. However, Mr. Landreth also indicated that neither EPA guidance documents nor draft standards reflect concerns for freeze-thaw cycling of liners or covers. Formulation of guidelines has apparently been hampered by the limited amount of research and the sometimes conflicting results of that research.

SUMMARY OF STUDY

The results of our study indicate that very limited (published) research has been performed studying the effects of freeze-thaw on permeability of soil liners. No information is presently available on the effects of freeze-thaw effects on a sand-bentonite composite liner (such as used on the W-105 project); all existing U.S. research has been directed at clay liners only. The results of our study also indicate that, at the present, negative effects of freeze-thaw have not been a permitting issue for RCRA sites.

RECOMMENDATIONS FOR FURTHER ACTION

In the absence of test data, no definitive conclusions can be drawn regarding the effect of freeze-thaw cycling on a soil-bentonite liner. Therefore, it is our opinion that if freeze-thaw of the W-105 soil liners is an issue, laboratory testing of the liner material should be conducted.

It is also our opinion that if freeze-thaw of a soil liner system becomes a regulatory issue, more than simple freezing of the soil liner must be studied. Based upon our experience and the discussions with the persons currently involved in this research, many facets of this issue require exploration. These include the following:

1. If an impoundment is left full, how much of the soil liner will actually freeze? If only a narrow rim of liner soil freezes near the top, what is the actual impact on the integrity of the liner system? Since the affected portion would be at the top of the liner system, fluid pressures through the synthetic system would be very low, and permeability would also expected to be low.

2. What are the thermal effects of the carbon-black enriched cover on the liner system? Given the number of cloudless days per year at the Hanford Site, the thermal effects minimizing or precluding freezing of the underlaying soil liner could be significant.

3. What are the actual effects of freeze-thaw on a soil-bentonite composite?

RESEARCH PERSONAL CONTACTS

1. Edwin Chamberlain, P.E. Geotechnical Engineering Division, U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory. Hanover, New Hampshire.

2. Mr. Thomas F. Zimmie, PhD, P.E. Associate Professor, Civil and Environmental Engineering Department, Renssalaer Polytechnic Institute. Troy, New York.

3. Mr. Hal Olsen. U. S. Geological Survey. Denver, Colorado.

4. Mr. Ken Kolm, PhD, P.E. U.S. Geological Survey Nevada Test Site Program. Denver, Colorado.

5. Mr. Thomas C. Kinney. Chairman, Frost Action Committee, Transportation Research Board. Fairbanks, Alaska.

6. Dr. David Daniel, PhD. University of Texas, Austin (presently on sabbatical at Drexel University; Allentown PA).

7. Mr. Paul Christianson. Oregon Department of Environmental Quality. Portland, Oregon.

8. Mr. Robert Landreth. Research Project Manager, U.S. Environmental Protection Agency. Cincinnati, Ohio.

9. Mr. James Nordquist, P.E. Applied Geotechnical Engineering Consultants. Salt Lake City, Utah.

REFERENCE DOCUMENTS

Chamberlain, Edwin J. Overconsolidation Effects of Ground Freezing. U.S. Army Cold Regions Research and Engineering Laboratory, 1981.

Chamberlain, E. J., Iskander, I. and Hunsicker, S. E. Effect of Freeze-Thaw Cycles on the Permeability and Macrostructure of Soils, in "Proceedings of the International Symposium on Frozen Soil Impacts on Agricultural, Range, and Forest Lands", 1991.

Chamberlain, E. J. and Ayorinde, O. A. Freeze-Thaw Effects on Clay Covers and Liners. U.S. Army Cold Regions Research and Engineering Laboratory, 1991.

Zimmie, T. F. and LaPlante, C. The Effect of Freeze/Thaw Cycles on the Permeability of a Fine-Grained Soil, in "Proceedings of the Twenty-Second Mid-Atlantic Industrial Waste Conference, Drexel University, 1990.

Zimmie, T.F., LaPlante, C., and Bronson, D.L. The Effects of Freezing and Thawing on Landfill Covers and Liners, in Proceedings of the Third International Symposium on Cold Regions Heat Transfer, University of Alaska Fairbanks, 1991.

Zimmie, T. F. and LaPlante, C. Freeze/Thaw Effects on the Hydraulic Conductivity of Compacted Clays. Draft copy of unpublished paper, yet to be presented.

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
S. H. Wisness, RL	T. L. Nord, Ecology	9106084

Subject: SOIL/BENTONITE REMEDIATION AND FREEZE MINIMUMIZATION PLANS

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